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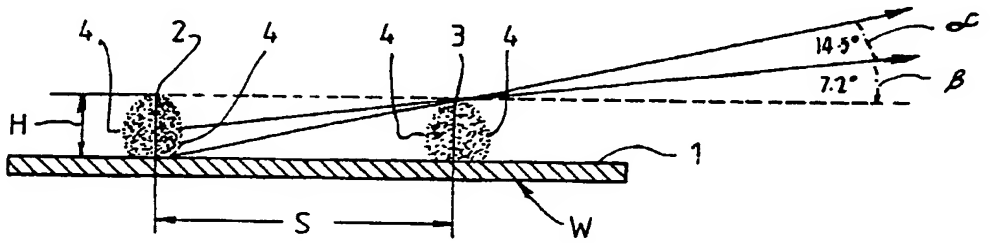
(54) Title: IMPROVED SECURITY DOCUMENTS



(57) Abstract: A security document, banknote, bond, travellers cheque, passport or token, including a substrate (1), said substrate having a device including a first macro-embossing (2, 3) of the substrate having a predetermined feature, and a second micro-embossing of smaller dimensions formed in or on said predetermined feature of said embossing. The first embossing being formed to hide and reveal said second embossing at predetermined viewing angles α, β. The macro-embossing may comprise lines having a height of about 20 microns and a spacing of 80 microns, and the micro-embossing in the form of lines or dots (4) to a height of about 2 to 5 microns. The lines have a predetermined height (H) and a predetermined spacing (S) such that the ratio S:H is typically from about 6:1 to 2:1. A transparent portion or clear window (W) of a polymer substrate (1) can be provided with embossing such that the first embossing is able to hide and reveal the finer second embossing at various viewing angles by using the gloss and transmission properties of the transparent substrate rather than the traditional reflection and absorption properties of the printed media.

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IMPROVED SECURITY DOCUMENTS

Field of the Invention

This invention relates to security documents or tokens, such as banknotes, travellers cheques, bonds, passports and the like, and to a method of producing same.

Background of the Invention

The use of transparent windows in banknotes is now well known, as exemplified by PCT/AU82/00135 (WO 83/00659) Improved Banknotes and the Like, as is their use as a carrier for security features. One of these features is a transitory image of the type described in PCT/AU94/00302 (WO 94/29119) Embossing of Banknotes. The transitory nature of the image produced by embossing relies on the properties on the transparent polymer film, including excellent transparency/clarity at most viewing angles, and high gloss or reflective characteristics when viewed perpendicular to a light source, as is observed with a mirror.

Summary of the Invention and Object

It is an object of the present invention to provide an improved security feature which includes an additional level of complexity, making the security feature more difficult to reproduce or copy.

The invention provides a security document or token, including a substrate, said substrate having a security device including a first embossing of the substrate having a predetermined feature, and a second embossing of smaller dimensions formed in or on said predetermined feature of said first embossing, said first embossing being formed to hide and reveal said second embossing at predetermined viewing angles.

In other words, the security device includes macro-embossing of the substrate and micro-embossing of a portion of the macro-embossing, the macro-

embossing functioning to hide and reveal the micro-embossing at predetermined viewing angles.

By forming a second embossing or micro-embossing on the first embossing or macro-embossing, the first embossing or macro-embossing hides and reveals the secondary embossing or micro-embossing at predetermined viewing angles, and in this way provides a security feature which is then able to be produced by high-level security producers at a reasonable price, while being extremely difficult for an average security producer or counterfeiter to reproduce or simulate. The security feature is optically variable, but is nevertheless easy for the person in the street to use to identify a genuine document.

The substrate is preferably a polymer substrate, such as a laminated polymer substrate of the type used in the production of banknotes in Australia and other countries. The first embossing is preferably formed in a transparent portion of the substrate, although acceptable results can be achieved by forming the embossed portion in other regions of the substrate.

In a preferred form of the invention, the secondary embossing is preferably applied to the sides or lower portions of the first embossing, or to portions of the substrate between adjacent first embossings.

By using the transparent portion of the polymer substrate, the first embossing is able to hide and reveal the finer second embossing at various viewing angles by using the gloss and transmission properties of the transparent substrate rather than the traditional reflection and absorption properties of printed media.

In a simple embodiment, the macro-embossing may comprise embossed array of lines formed in the substrate, the lines having a predetermined height H and a predetermined spacing S. The height H may vary from a minimum of about 5 microns to a maximum corresponding to the maximum embossable height of the substrate. The spacing S depends on the height and the ratio S:H is typically from about 6:1 to 2:1. The micro-embossing may be formed as lines or dots on the sides of the embossed lines such that the secondary embossed

lines are hidden by the primary embossed lines other than at a predetermined range of angles. The secondary lines or dots are embossed to a height to the order of about 2 microns to about 20 microns which causes the clear substrate to appear matt at the predetermined viewing angles. If desired, lower portions of the macro-embossing, or portions of the substrate between adjacent macro-embossings, can be micro-embossed, either in addition to the sides, or as an alternative thereto.

In a preferred embodiment, the macro-embossing comprises lines having a height of from about 5μm to 3μm at a spacing of about 10μm to 100μm, and preferably a height of about 10μm to about 25μm and a spacing of about 30μm to 100μm. The upstanding lines created by the macro-embossing are micro-embossed with lines or dots on their sides in a manner which causes the clear substrate to appear matt at viewing angles of about 5° to about 45° to the surface of the substrate. The micro-embossing may be configured to form composite shapes, portraits, or any other recognisable device.

The macro and micro-embossing can be performed as part of the printing process and is particularly adapted to the intaglio printing process. Such processes are more clearly described in our prior application WO 94/29119.

The invention further provides a method of producing a security document or token, including forming an embossed security device in the substrate, and further embossing the embossed security device with a smaller embossing, such that the embossed security device hides and reveals the smaller embossing at predetermined viewing angles.

The security device is preferably embossed to a height of about 10 to 30 microns, and the sides of the embossing are in turn embossed to a height of about 2 to 20 microns the further embossing being positioned so that the first embossing hides and reveals the secondary embossing at predetermined viewing angles.

Description of the Preferred Embodiment

In order that the invention may be more readily understood, a preferred embodiment will now be described with reference to the accompanying drawings in which:

Figure 1 is a schematic elevation of part of a banknote embossed in accordance with the invention;

Figure 2 is a schematic representation of the banknote when viewed at a predetermined angle which reveals the micro-embossing;

Figure 3 is a view similar to Figure 2 in which a banknote is viewed at an angle which hides the micro-embossing;

Figure 4A is a schematic representation of a document embodying the invention when viewed;

Figure 4B illustrates various indicia when view under different conditions;

Figure 5 is a plan view of a printed document, such as a banknote, having the macro-embossing positioned within a clear window in the document;

Figure 6A to 6H illustrates schematically the process of manufacturing a macro-embossing intaglio plate;

Figures 7A to 7M illustrates schematically the process of manufacturing a micro-embossing intaglio plate;

Figure 8 illustrates the calculation of the elongation ratio used in the formation of a micro-mask for creating a desired image in the micro-embossing.

Description of Preferred Embodiment

Referring firstly to Figures 1 to 4, a simple embodiment of the invention is depicted in Figure 1 as including a substrate 1, such as the Guardian substrate used for the production of banknotes, and comprising a laminate of polymer film having a printed portion P and clear window portion L, as illustrated in Figure 5, which has been macro-embossed with a series of parallel embossed lines 2, 3 having a height of about 20μm and a spacing of 80μm, each macro-embossed line having micro-embossing in the form of lines or dots 4 to a height

of about 2μm to 5μm formed on its sides, such that the micro-embossing 4 is visible when viewed at angles equal or greater than α (14.5°), and is hidden when viewed at angles less than β (7.2°) as illustrated in Figures 1 and 2 and 1 and 3 respectively.

In Figure 4A, the document substrate 1 is shown at a typical viewing angle of about 30° from normal and from this position the document can be tilted left or right, rotated up and down, or pivoted to the right or left, or any combination thereof. When viewed in this way, the clear window W appears to be substantially transparent, as illustrated in (d) of Figure 4B. In the illustration of Figure 4B the macro-embossed lines comprise a set of vertical parallel lines and a set of horizontal parallel lines in a generally triangular pattern, as illustrated in (a) of Figure 4B. When this pattern is held at right angles to the light source, the horizontal lines are substantially transparent while the vertical lines are visible, as illustrated in (b) of Figure 4B. Conversely, when the horizontal lines are at right angles to the light source, the horizontal lines are visible and the vertical lines are substantially transparent as illustrated in (c) of Figure 4B. Thus, the sets of lines have three phases;

1. where a set of lines runs perpendicular to a light source, the image appears because the lines are reflecting light.
2. where a set of lines runs in the same direction as the light source, then this set of lines appears substantially transparent, and
3. where the light source is diffuse and the observer is looking through the clear area, the macro embossed lines are substantially invisible, as illustrated in (d) of Figure 4B.

The micro-embossing 4 generates a secondary image that causes the embossed portions of the clear window W of the substrate 1 to appear matt when viewed at predetermined angles. Referring to Annexure B, the image at first becomes visible at the angle β (7.2° in this case). At angle α (14.5° in this case) all of the micro-embossing is visible. The image will not be to scale at this point. The image will be optimal at this angle in terms of continuity (low U/V ratio). However, the elongation angles have not been calculated at this

angle. The chosen viewing angle for calculation of elongation angle is higher: 30°.

The image will be "recognisable" up to an angle of about 45°. The reason the image can not be viewed at angles higher than this is because the matt lines will become thinner and the apparent spacing will become wider, as illustrated in Annexure B.

The chosen viewing angle is chosen by: Average (14.5, 45) = 30°.

The micro-embossing can be in the form of lines or dots of about 2 to about 5μm in height. When micro lines/dots of this height are embossed to the sides of the macro-embossed lines 2, 3 using an intaglio printing machine, the lines maintain a particularly high fidelity since the polymer of the substrate 1 has a high molecular weight. Alternatively similar results are achieved when the micro lines/dots are formed on the portions of the substrate 1 between the lines 2, 3, either instead of the side embossings, or in addition thereto.

The space to height ratio S:H should be in the range of about 6:1 to about 2:1. The height may vary from about 5μm to about 30μm, which is close to the limit for the polymer substrate 1 of the preferred embodiment, although acceptable results are achievable in the height range from about 5μm to about 20μm. Within this range, the spacing between lines S can vary between about 15μm and about 20μm for a height of 5μm, between about 30μm and about 50μm for a height of 10μm, between about 30μm and about 90μm for a height of 15μm, between about 40μm and about 100μm for a height of 20μm, between about 50μm and about 100μm for a height of 25μm, between about 60μm and about 90μm f or a height of 30μm, between about 65μm and about 75μm for a height of 35μm. The table of Annexure A illustrates the preferred height and spacing parameters, with the shaded area representing the most preferred spacings for heights between 5 and 35μm. See annexed Table.

As illustrated in Figure 5, the macro-embossing comprises horizontal lines, while the micro-embossing is performed in a manner which includes a

micro-mask which reproduces a device such as an arrow, having the appearance illustrated in Figure 5, when the document is tilted down and up respectively.

Turning now to Figures 6 to 8 of the drawings, the macro-embossing process is illustrated in Figures 6A to 6H and comprises the following steps:

1. Spin photo-resist polymer over a copper metal plate at an even thickness of up to 3µm .
2. Position the macro-emboss mask over the photo-resist polymer.
3. Irradiate the surface with UV lamps.
4. Remove the UV lamps.
5. Remove the macro-emboss mask.
6. Dissolve and wash away the unexposed photo-resist polymer.
7. Using a ferric chloride and copper solution, etch the macro-emboss structure.
8. Remove the photo-resist polymer.

If desired the process can be preformed in opposite photo-resist, using negatives instead of positives.

Figures 7A to 7M illustrate the preferred micro-embossing process, which involves the following steps:

1. Using the same plate as was used for the macro-embossing, spin photo-resist polymer over the metal plate, ensuring the resist enters at an even thickness into the macro-embossed structure, as shown in Figure 7A.
2. Position the revised macro mask into the same position as the original macro mask. The revised macro mask will have the centre of all the macro-embossed lines removed.
3. Irradiate the surface with UV lamps. This should be performed to ensure the non-engraved sections of the plate and the bottom section of the macro-embosses are exposed.
4. Remove the UV lamps.
5. Remove the revised macro-emboss mask.
6. Position the first micro-embossing mask A over the photo-resist. Mask A consists of an elongated image. The image is elongated such that when

viewed at the preferred optimum viewing angle of about 30°, the image appears in scale.

7. Irradiate the surface with UV lamps. The UV lamps should be placed at the optimum viewing angle of about 30° to the horizontal. These Lamps must irradiate a uniform light in order to create the correct exposure patterns as shown in figure 6.

8. Remove the UV lamps.

9. Remove Mask A.

10. Position the second micro-embossing mask B over the photo-resist. Mask B also consists of an elongated image, with an optimum viewing angle of 30°. Mask B may consist of a different image to Mask A.

11. Irradiate the surface with UV lamps. The UV lamps should be placed at the optimum viewing angle of about 30° to the horizontal, in the opposite direction as for Mask A.

12. Remove the UV lamps.

13. Remove Mask B.

14. Dissolve and wash away the unexposed photo-resist.

15. Using hydrochloric acid, etch the micro-emboss structures.

16. Remove the photo-resist polymer.

In the above process, both the micro-mask A and the micro-mask B consist of elongated images. The extent of the elongation is predetermined by the preferred viewing angle. The preferred viewing angle has been set at about 30° to the document.

Elongation Ratio; $x/y = 1/\sin(\text{gamma})$

x = elongated length of image on substrate

y = image viewing height

With an optimum viewing angle of 30°, the extent of elongation is 2:1. For example, if an image has a viewing height of 15mm, then the image created by the micro-mask will be 30 mm long on the substrate. The image is only to be elongated in the vertical viewing direction.

Following the above processes, the intaglio plate for achieving the macro and micro-embossing is made by the following steps:

1. A nickel metal plate is grown from the copper plate.
2. The nickel plate is pressed into a sheet of PVC.
3. PVC tiles are cut out and welded into the greater intaglio design. The directional embossing images are usually a subset of an overall intaglio design.
4. The metal printing plate is manufactured form the welded PVC master-tiles.
5. Intaglio printing is performed as described in WO 94/29119. Some areas of the intaglio plate may be inked as for traditional intaglio printing. The area of the intaglio plate which is intended for the directional emboss feature will not be inked.

The embossing process is a continuous process whereby the substrate to be embossed is passed through two rolling cylinders under high pressure. The embossed intaglio plate covers one of the two cylinders, the other cylinder is the impression cylinder. During the process, the substrate is forced into etchings of the plate by the impression cylinder. The substrate plastically deforms into the shape of the etchings. When the substrate exits the rolling cylinders, the macro-emboss reflexes partially back into shape, due to the nature of the material. The embossing on the substrate remains intact. However, the height of the embossing does not equal the height of the etching on the plate, a typical ratio is about 1:5. For this reason the maximum foreseeable final emboss on the relaxed substrate is about 35 – 40 μm.

RATIO S:H	α	β
1	45.00	22.50
2	26.57	13.28
3	18.43	9.22
4	14.04	7.02
5	11.31	5.65
6	9.46	4.73
7	8.13	4.07
8	7.13	3.56
9	6.34	3.17
10	5.71	2.86
11	5.19	2.60
12	4.76	2.38
13	4.40	2.20
14	4.09	2.04
15	3.81	1.91

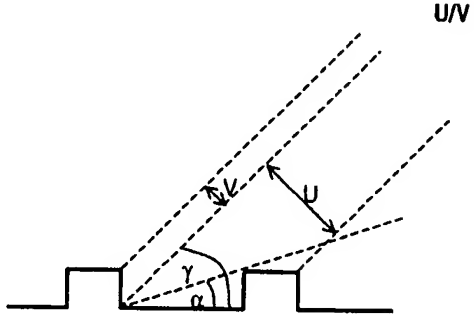
MAX U/V [5]

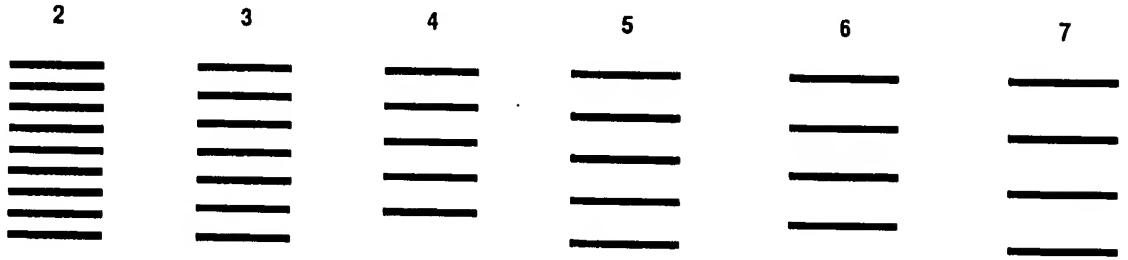
Viewing Angle, γ (degrees)

U/V RATIO

10	15	20	25	30	35	40	45	50	55	60
					0.18	0.37	0.59	0.83	1.11	1.46
		0.03	0.30	0.58	0.88	1.21	1.59	2.02	2.54	3.20
	0.04	0.39	0.76	1.15	1.58	2.05	2.59	3.21	3.97	4.93
	0.30	0.76	1.23	1.73	2.28	2.89	3.59	4.40		
0.04	0.57	1.12	1.69	2.31	2.98	3.73	4.59			
0.22	0.84	1.48	2.16	2.89	3.68	4.57				
0.40	1.11	1.85	2.63	3.46	4.38					
0.57	1.38	2.21	3.09	4.04						
0.75	1.64	2.58	3.56	4.62						
0.92	1.91	2.94	4.03							
1.10	2.18	3.30	4.49							
1.28	2.45	3.67	4.96							
1.45	2.72	4.03								
1.63	2.98	4.40								

The horozontal range is the acceptable viewing range for a given S:H ratio





RATIO S:H	α	β
1	45.00	22.50
2	26.57	13.28
3	18.43	9.22
4	14.04	7.02
5	11.31	5.65
6	9.46	4.73
7	8.13	4.07
8	7.13	3.56
9	6.34	3.17
10	5.71	2.86
11	5.19	2.60
12	4.76	2.38
13	4.40	2.20
14	4.09	2.04
15	3.81	1.91

Height (μm)	2	5	10	15	20	25	30	35	40	45	50
Spacing (μm)											
2	5	10	15	20	25	30	35	40	45	50	
4	10	20							80	90	100
6								105	120	135	150
8					80		120	140	160	180	200
10	25					125	150	175	200	225	250
12	30	60		120	150	180	210	240	270	300	
14	35	70	105	140	175	210	245	280	315	350	
16	40	80	120	160	200	240	280	320	360	400	
18	45	90	135	180	225	270	315	360	405	450	
20	50	100	150	200	250	300	350	400	450	500	
22	55	110	165	220	275	330	385	440	495	550	
24	60	120	180	240	300	360	420	480	540	600	
26	65	130	195	260	325	390	455	520	585	650	
28	70	140	210	280	350	420	490	560	630	700	
30	75	150	225	300	375	450	525	600	675	750	

CLAIMS:

1. A security document or token, including a substrate, said substrate having a security device including a first embossing of the substrate having a predetermined feature, and a second embossing of smaller dimensions formed in or on said predetermined feature of said first embossing, said first embossing being formed to hide and reveal said second embossing at predetermined viewing angles.

2. The document or token of claim 1, wherein the substrate is a polymer substrate, such as a laminated polymer sheet of the type used in the production of banknotes.

3. The document or token of claim 1 or 2, wherein the first embossing is formed in a transparent portion of the substrate.

4. The document or token of claims 1, 2 or 3, wherein the secondary embossing is formed in the sides or lower portions of the first embossing or to portions of the substrate between adjacent first embossings.

5. The document or token of any preceding claim, wherein the first embossing includes lines or dots having a height H and spacing S, the height varying from about 5 microns to a maximum corresponding to the maximum embossable height for the particular substrate, the spacing depending on the height with the ratio S:H varying from about 6:1 to about 2:1.

6. The document or token of claim 5, wherein the secondary embossing includes lines or dots which are embossed to a height of about 2 microns to about 6 microns.

7. The document or token of claim 5 or 6, wherein the first embossings have a height of about 5 microns to about 30 microns and a spacing of about 10 microns to about 100 microns.

8. The document or token of, claim 7, wherein the height is from about 10 microns to about 25 microns and the spacing is from about 30 microns to about 100 microns, the second embossing being such that the substrate appears matt at viewing angles between about 5° and 45° to the surface of the substrate.

9. A method of producing a security document or token, including forming an embossed security device in the substrate, and further embossing the embossed security device with a smaller embossing, such that the embossed security device hides and reveals the smaller embossing at predetermined viewing angles.

10. The method of claim 9, wherein the document or token is embossed in the manner claimed in any one of claims 3 to 8.

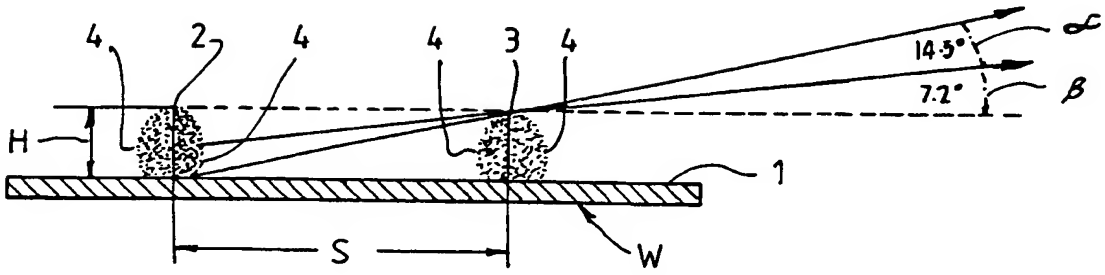


FIG. 1.

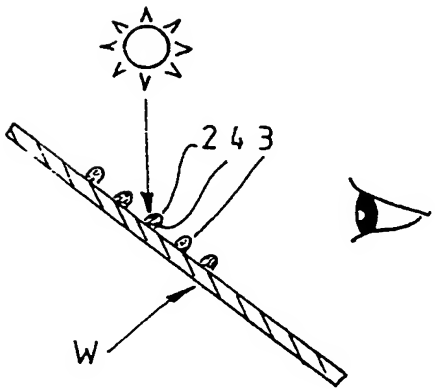


FIG. 2.

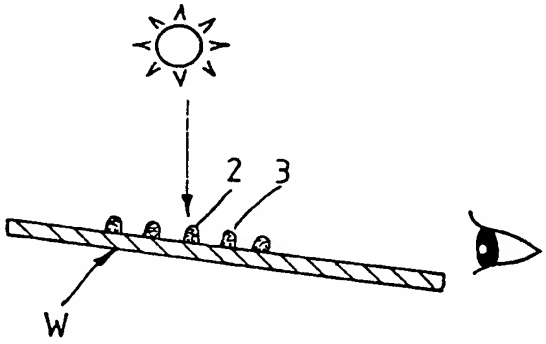


FIG. 3.

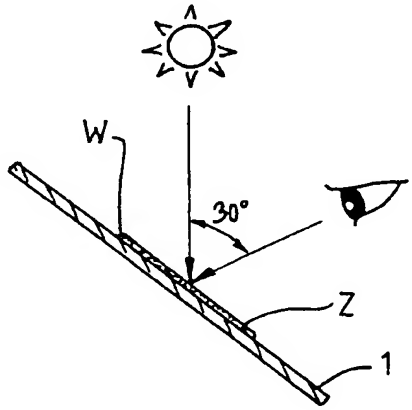


FIG. 4A.

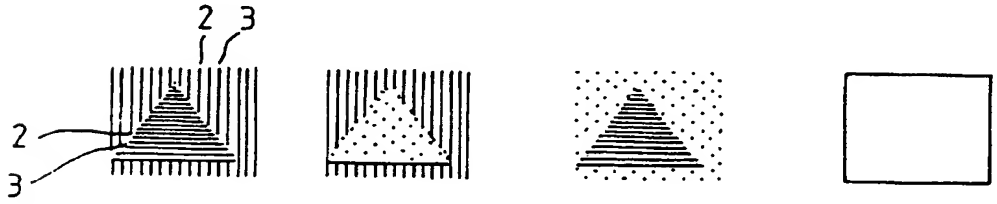


FIG. 4B.

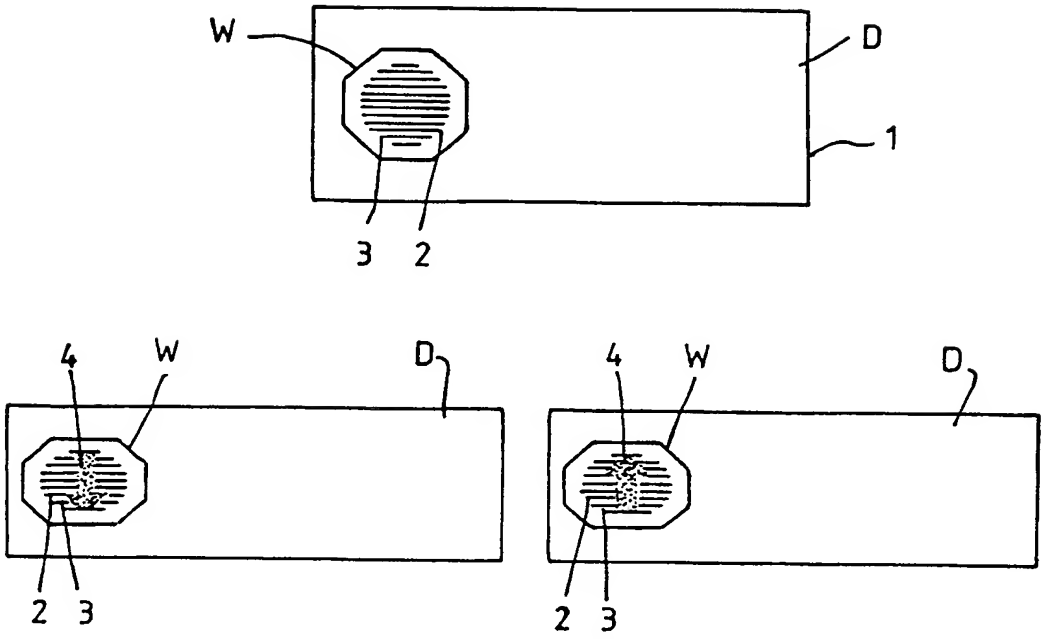
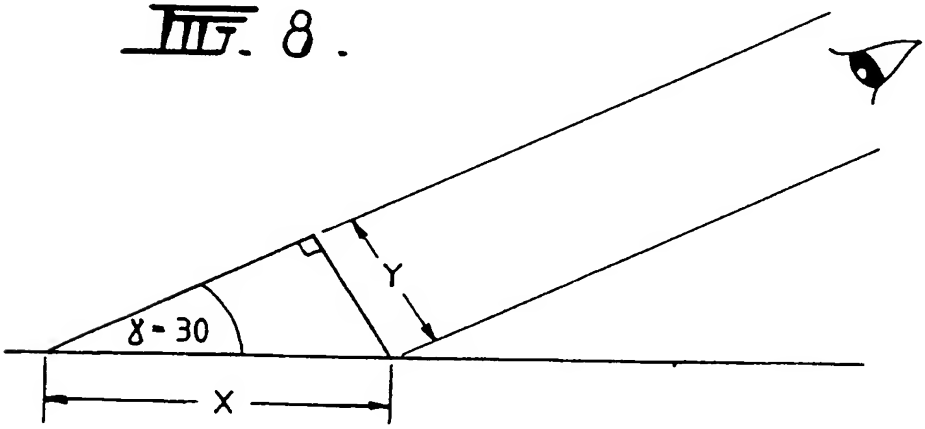


FIG. 5.

FIG. 8.



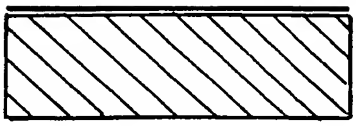


FIG. 6A.

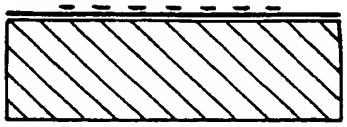


FIG. 6B.

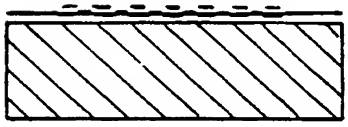


FIG. 6C.

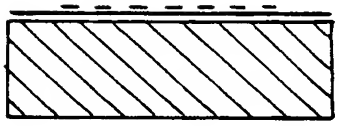


FIG. 6D.

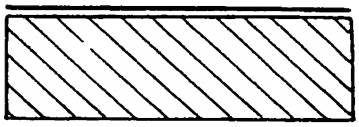


FIG. 6E.

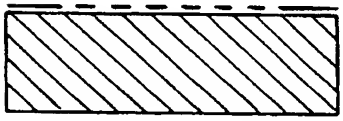


FIG. 6F.

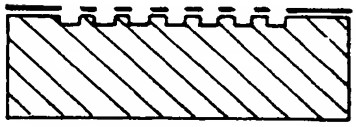


FIG. 6G.

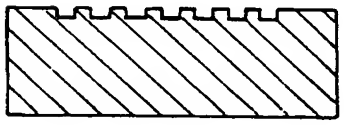


FIG. 6H.

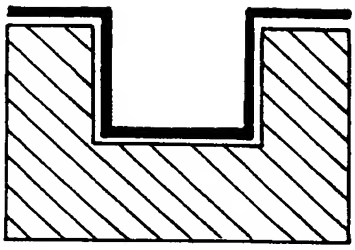


FIG. 7G

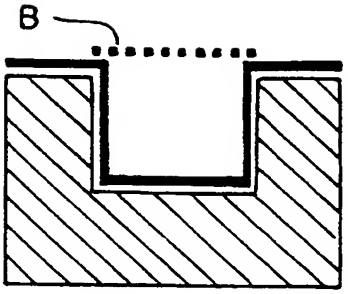


FIG. 7H

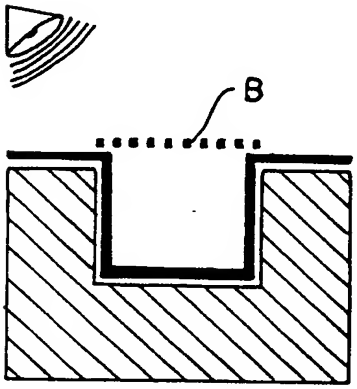


FIG. 7I

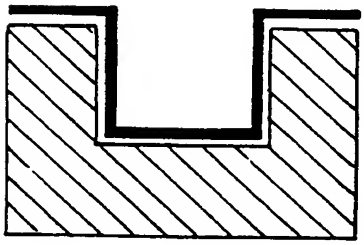


FIG. 7J

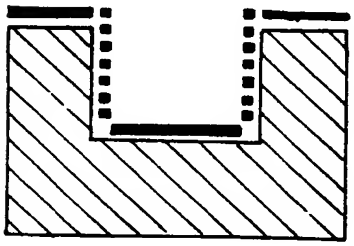


FIG. 7K

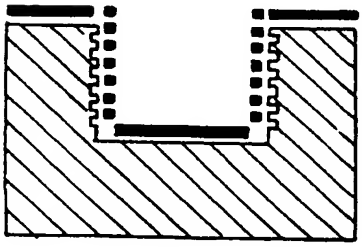


FIG. 7L

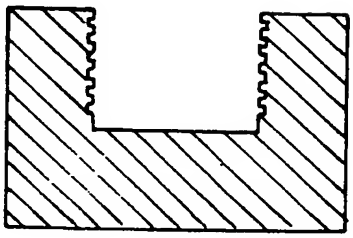


FIG. 7M

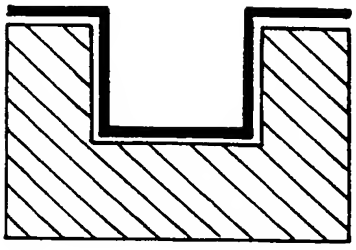


FIG. 7G

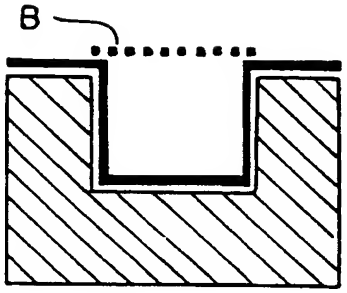


FIG. 7H

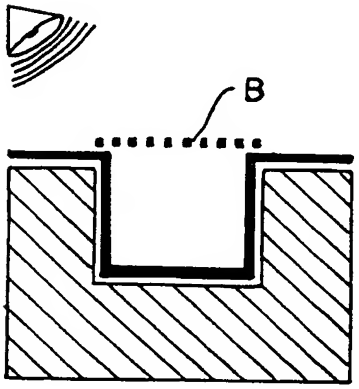


FIG. 7I

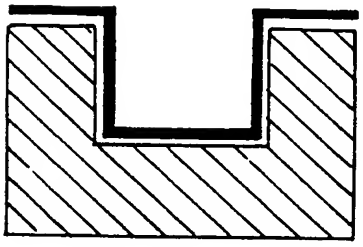


FIG. 7J

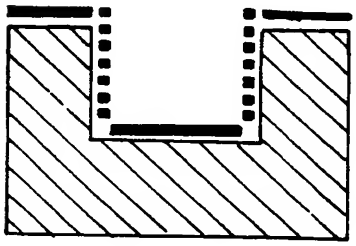


FIG. 7K

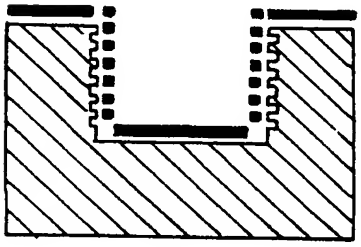


FIG. 7L

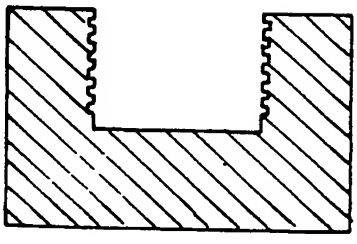


FIG. 7M

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU00/00703

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl. [7]: B44F 1/12, B41M 3/14, G02B 5/18, 27/42, B42D 15/10 // B42D 213:00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC: B44F 1/12, B41M 3/14, G02B 5/18, 27/42, B42D 15/10 // B42D 213:00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
AU: B44F 1/12, B41M 3/14, G02B 5/18, 27/42

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
WPAT

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0194042 A (BRADURY WILINSON (CHEQUES) LIMITED 10 September 1986 Whole document	1-10
X	CA 2224758 A (WICKER et al) 16 December 1998 Whole document	1-10
X	WO 94/29119 A (RESERVE BANK OF AUSTRALIA) 22 December 1994 Whole document and cited in the specification	1-10

[X] Further documents are listed in the continuation of Box C [X] See patent family annex

* Special categories of cited documents:

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"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
7 July 2000	12 JUL 2000
Name and mailing address of the ISA/AU AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA E-mail address: pct@ipaustralia.gov.au Facsimile No. (02) 6285 3929	Authorized officer A.G. **ADRIANO GIACOBETTI** Telephone No : (02) 6283 2579

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU00/00703

C (Continuation). **DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 90/02658 A (THE DE LA RUE COMPANY PLC) 22 March 1990 Whole document	1-10
X	US 4033059 A (HUTTON et al) 5 July 1977 Whole document	1-10

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/AU00/00703

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member					
EP	194042	GB	2177975				
CA	2224758	NONE					
WO	94/29119	AU	69209/94	CA	2164629	CN	1124940
		EP	710183	FI	955882	NO	954908
		NZ	267032	SG	44393	US	5915731
WO	90/02658	BR	8907637	CA	1335509	EP	433330
		GB	2241668	HK	1058/94	SG	47/94
		US	5199744				
US	4033059	CA	965125	DE	2334702	FR	2192496
		GB	1390302	IT	1006062	JP	49-043718

END OF ANNEX